Climate Challenge India

centre for social markets

INDIA
RENEWABLE ENERGY TRENDS

Alexis Ringwald

July 2008

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The Centre for Social Markets (CSM) is an independent, non-profit organization dedicated to making markets work for the triple bottom line – people, planet and profit. Through offices in India and the UK, and an international network of partners and associates, CSM works to accelerate the transition to sustainable development and the realization of human rights and social justice. Founded in 2000, by Indian social entrepreneur, Malini Mehra, CSM's primary constituencies are domestic industry and stakeholders in developing countries, and Diaspora communities in industrialized countries.

From 2007 onwards, CSM has focused its attention on three major programme areas where it seeks to bring challenge and leadership:

(1) **Climate Change** – lead a major public engagement initiative, 'Climate Challenge India', to promote a pro-active domestic response to climate change in India.

(2) **India as a Global Player** – examine India's emergence as a major player on the global stage with particular reference to sustainability and human rights challenges.

(3) **Corporate Responsibility** – undertake innovative research, education and leadership programmes as India Inc. goes global.

About this Discussion Paper series

This paper is part of a new Discussion Paper series launched by CSM in 2008 under the 'Climate Challenge India' initiative. The series seeks to provide a platform for fresh and challenging thinking on a range of issues connected to climate change in India. The objective is to deepen and broaden public understanding of this vital subject in India through easily accessible and informative material. In turn, it is hoped that this will contribute to a better-informed public debate and more progressive policy outcomes on climate change for India, her people and neighbourhood.

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CONTENT

Preface

As this publication goes to press, the meeting of the G8 group of nations in Hokkaido, Japan, is drawing to a close and world leaders have issued a declaration committing themselves to reducing CO_2 emissions by 50% by 2050 to avert dangerous climate change. India was also present at the G8 Summit, as in previous years, as a member of the 0-5 (Outreach 5) group of emerging economies whose influence on global affairs has won them a place at the high-table of international institutions.

This year, as in no other, the inter-related issues of climate change, oil and food price rises dominated the agenda of the G8 Summit. This, combined with the downturn in the global economy and fears of a recession in major nations, focused minds on the need to devise immediate and collective responses to curb the volatility and insecurity in global energy markets. With the price of oil projected to reach $200/ barrel by the end of the year, politicians know that we are in dangerous and uncharted waters with prospects of economic meltdown and civil unrest a real possibility – if not already a reality – in many parts of the world.

Into this scenario comes the stark warning from the Chair of the UN Intergovernmental Panel on Climate Change, Dr RK Pachauri, that global emissions of greenhouse gases need to peak by 2015 if we are to avoid even more severe impacts of climate change. According to the International Energy Agency's (IEA) projections, India will become the third-largest emitter by around precisely this time.

These trends underscore the need for urgent and effective action to address climate change and energy security – and related insecurities such as food and water – in an integrated manner. As the IEA noted in its World Energy Outlook 2007, the "primary scarcity facing the planet is not of natural resources nor money, but time," as "Investment now being made in energy-supply infrastructure will lock in technology for decades, especially in power generation. The next ten years will be crucial, as the pace of expansion in energy-supply infrastructure is expected to be particularly rapid." The report concludes that China's and India's energy challenges will thus be the world's energy challenges and call for collective responses.

Fortunately, we know the answers to many of these dilemmas - and more of them are around the corner. Among the indisputable array of solutions to lowering emissions and providing energy security is the important role to be played by renewable energy. The global energy and economic scenario has now conspired to create – and, many would argue, not a moment too soon - the conditions for a renaissance of renewable energy the likes of which we have not seen since the early-1970s. Only this time, it is likely to grow – and grow – until it becomes established as a core and unshakeable part of energy systems everywhere. The seven trends outlined in this paper explain just why this may well turn out to be the case in India.

Each of these trends is an exciting story of just how different dimensions of the energy, economy, environment and employment challenge are finally coming together to offer solutions that amount to more than just the sum of their parts. If the potential they represent is seized with the intensity and commitment required, the future for India will be green and bright.

Private actors, aided by supportive government policy, are beginning to make a bee line in the right direction. For example, this week in Delhi sees the convening of the 2nd India Cleantech Forum (10-11 July 2008), an important industry event bringing together some of the leading innovators in this exciting emerging field.

We are delighted to have teamed up with the organisers to launch this CSM Discussion Paper on 'INDIA Renewable Energy Trends' at the 2nd Cleantech Forum, as the most appropriate venue for its release. Future papers under this series will cover related issues of the energy and climate challenge for India including the role of methanol, energy efficiency, nuclear, biofuels, etc.

We are grateful for the support received from the United States Educational Foundation in India (USEFI) in publishing this paper, and commend Alexis Ringwald's research into India's renewable energy renaissance to our readers in the hope that it both educates and inspires existing and future climate innovators.

Malini Mehra
Series Editor
Founder & Chief Executive, CSM

July 2008

Foreword

This paper provides an objective analysis of present day trends in renewable energy in India. Without going unnecessarily into the history and evolution of this sector in the Indian context, the paper seeks to take stock of the current focus and initiatives. The author has avoided the temptation of giving policy prescriptions for the growth of the sector. Without being critical, she has underscored the need for more of a thrust and innovative approach to accelerating the growth of the sector.

Depending on the preferences and interests of the reader, the basic objectives of the renewable energy programme - energy security, economics and environment - may vary in importance. The Ministry of New and Renewable Energy, that was set up more than 25 years ago primarily from the point of view of energy security, has been playing a pioneering role in protection of environment as well as industrial growth linked to renewable energy. Though one can be quite critical of the performance in the eighties and nineties, new momentum has been provided in the recent past by concerns on climate change. This coupled with the energy shortage has attracted the attention of players in the private sector to contribute meaningfully to this vital sector.

New policy initiatives and the development of viable business models in the private sector have spurred growth during the last two years. India has reached a stage where it is admitted by all that renewable energy is one of the most essential and sustainable solutions. It is obvious from the paper that the author has not only interacted with a wide cross-section of stakeholders in the renewable energy sector, but has also brought them into focus in analyzing their points of view. I consider this a very balanced, objective and focused paper on the current trends of renewable energy in India.

V Subramanian
Secretary to the Government of India
Ministry of New and Renewable Energy
New Delhi, India.
May 2008

Introduction

There is great excitement at the prospect of India becoming the world's next clean energy 'hot spot'. The reasons are manifold. Perhaps it was the announcement of plans to construct India's first multi-megawatt solar photovoltaic (PV) power plant; or the success of India's home-grown wind entrepreneurs; or the recent carbon market mania. Or maybe it was a combination of escalating concerns about India's unreliable electricity infrastructure; the entrepreneurial challenge to provide electricity to India's 400 million energy poor; or the anxiety surrounding the release of Tata Motor's low-cost $2500 petrol car and its impact on congestion and pollution.

Whatever the reason, more than anything, it is surely the recognition that India, after China, is set to experience the greatest increase in energy and greenhouse gas (GHG) emissions globally, and must take critical steps today, at this important juncture in its development, to avoid "lock-in" to an obsolete high emissions trajectory.

Until the recent momentum of the last couple years, India's progress in renewable energy remained gradual despite it being the only country in the world with a separate Ministry of New and Renewable Energy (MNRE). In 2007 and early 2008, however, the three "E's" of "energy security, economics and the environment," began to resonate outside the halls of the Ministry and permeate national politics, industry and the media. With "climate change" and "growing energy demand" as the sensational headlines of the year, "clean energy" seemed poised to become an indispensable mantra for India's future development.

"Clean energy" generally covers renewable energy, energy efficiency and clean fossil fuel technology. This discussion paper will focus on just one of these: renewable energy. While it must

be acknowledged that clean coal technology may be the biggest clean energy technology in India, along with energy efficiency and conservation in buildings and transport, there is also a significant and profitable role for renewable energy technologies to play.

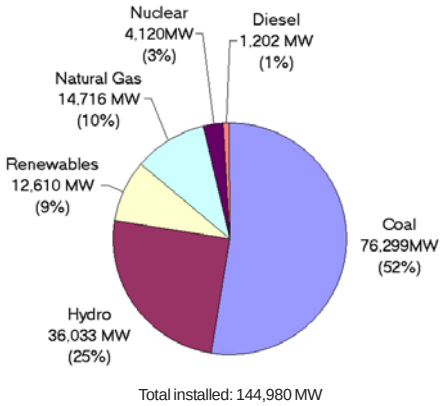
Building on India's tremendous drive over the past few years, the seven trends outlined in the following pages reveal exciting developments to come and suggest that with continued momentum renewable energy *can be* and *should be* one of India's most essential sustaining and sustainable solutions.

Energy Overview

To sustain India's staggering 8% annual economic growth and support the country's population as it expands from 1.13 billion people today to becoming the most populous nation by 2030, India's primary energy demand will necessarily multiply three to four times (IEA 2007). In absolute terms, this means an increase in energy demand from 542 million tons of oil equivalent (Mtoe) in 2006, to 842 Mtoe in 2016, to 1836 Mtoe in 2031 (Planning Commission 2006), an increase that will move India from being the fourth largest energy consumer in the world today to the third largest by 2030, after China and the USA (IEA 2007).

To finance such a supply build-out will require $1.25 trillion invested in energy infrastructure between 2006-2030, with more than three-quarters of this investment in the power sector (IEA 2007).

Figure 1: India Installed Power Capacity (MW)



Note: Data as of June 2008.
Source: CEA, 2008; MNRE, 2008a.

Currently India ranks fifth globally in installed power capacity with nearly 145 GW (IEA 2007, CEA 2008). For comparison, the USA and China possessed 1076 GW and 710 GW, respectively, at the end of 2007, with China expecting to grow to 800 GW by the end of 2008. In India, coal-based generation contributes to 76 GW of electricity, while renewables[1] comprise 48.6 GW including large hydro and 12.6 GW without (see Figure 1). For a country of India's size, 145 GW is clearly not enough and, as a result, India

[1] "Renewables," according to India's definition, include biomass, wind, solar, small hydro (less than 25MW), bagasse, and waste-to-energy. A complete list of sources is available on page 14.

experiences an electricity deficit of 12%, and a peak shortage of 16.7%; technical and commercial losses from both theft and poor transmission and distribution average approximately 40% (CEA 2008). On top of this, over 400 million Indians are estimated to have no access to electricity (IEA 2007).

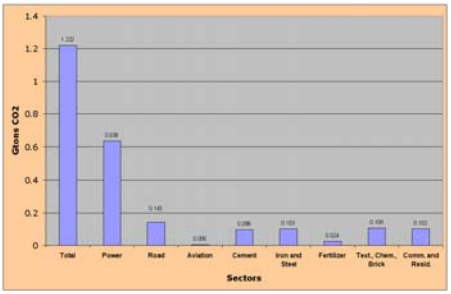
Looking ahead, India's 11th Five Year Plan calls for 80 GW of new electric power to be built between 2007 and 2012, a figure which includes 14 GW from renewable energy (CEA 2008). This signifies a massive build-up in comparison to the 27 GW of electric power constructed during the previous 10th Five Year Plan, approximately 25% of which came from renewables (*ibid*). By comparison, China, installed 90 GW of power in the year 2007 alone (Graham-Harrison 2008). By 2030, meanwhile, the Government of India (GoI) expects to possess 800 GW (close to China's capacity in 2008), an expansion nearly six times above today's levels (*ibid*).

With regard to oil, India relies heavily on imports to meet 75% of its needs, a dependence that would rise to above 90% by 2030, if alternatives were not promoted. On top of the clear potential threat to energy security, the economic costs of this oil dependence are high with the GoI expecting to pay as much as $57.8 billion in subsidies in 2008 - an amount more than 3% of the country's GDP (Financial Times 2008). Natural gas, meanwhile, an increasingly popular choice for both power and transport represents additional challenges concerning import dependence and rising prices. India's energy situation is, therefore, precarious and all top-level decision-makers recognize the important role that alternative energy must play.

Current Emissions Scenario

In 2007, in a moving speech about global warming, Jairam Ramesh, then Minister of State for Power, asserted, "If India wants to be a global super power, it must also take on global super responsibilities" (Ramesh 2007). Reconciling India's emerging global ambitions with its growing obligation to protect a planet on which one out of every six people will be Indian has proved to be a complex matter. While it must certainly be acknowledged that India is not an historical emitter, unlike the USA or Europe, the numbers on future sources of emissions from the emerging "global super power" are extremely compelling with India set to become the third-largest emitter of energy-related CO_2 by 2015 (IEA 2007).

Figure 2: Sectoral Emissions in India



Source: Garg, 2006.

Out of India's annual 1.2 Gigatons (Gt) of CO_2 emissions, the power sector is responsible for just over half (see Figure 2). This is due to the fact that India relies on many low efficiency power plants, which on average produce 0.94 kg of CO_2 per kWh - more than 50% higher than the world average (IEA 2007).

In an effort to understand the implications of several possible future energy paths, India's Planning Commission assessed CO_2 emissions generated from energy use in eleven different scenarios varying from a coal-dominant scenario to a scenario with significant efficiency, demand-side management measures and renewables. According to the study, the difference between the best and worst scenarios was nearly 35% (Planning Commission 2006: 50). Overall emissions would escalate from today's low 1.2 Gt per year to as high as 5.5 Gt per year by 2031-32 in the business-as-usual scenario, and 3.9 Gt in a more clean

energy focused path (*ibid*). The Planning Commission, mindful of the gravity of these decisions, concluded: "The carbon emission implications of our scenarios are, therefore, significant" (Planning Commission 2006: 50).

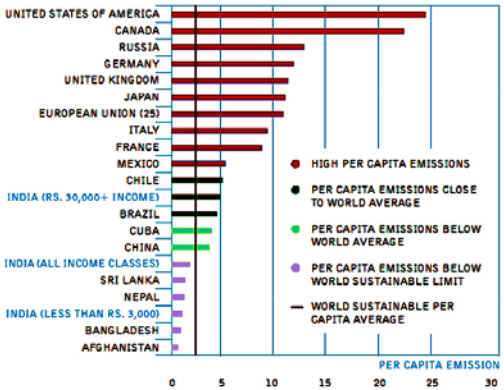
Despite the high-level of awareness of this issue, however, Indian decision-makers find it difficult to take a unified stance on climate change, especially due to issues surrounding enduring inequities between rich and poor. Pointing out India's low national average per capita carbon dioxide (CO_2) emissions of 1.67 tonnes (significantly below the USA's 23 tonnes or Europe's 11 tonnes), many say that India has a large allowance within which emissions may grow. It may, however, be that "Indian climate politics fall short if it only refers to national per capita CO_2 levels" (Greenpeace India 2007: 13). According to the Greenpeace India report "Hiding Behind the Poor," the highest income group in India earning above $750 (INR 30,000) per month emits 4.97 tonnes of CO_2 per capita, nearly equivalent to the world average of 5.03 tonnes (see Figure 3).[2] More startling, the average CO_2 emissions of an individual from this high income group, consisting of 1% of the country's population, are estimated to be 3.7 times more than 73% of the population earning less than $125 (INR 5000).

Thus, asserts G. Ananthapadmanabhan, Executive Director of Greenpeace India, "The government continues to point at low average per capita emissions to justify non-reduction of India's CO_2 emissions... [However,] India's low average per capita emissions is due to the over 800 million poor population whose emissions are negligible" (Times of India 2007). As at the *international* level, where there is common but differentiated responsibility, the report suggests that there perhaps should also be an "*intra-national* common but differentiated responsibility" that distinguishes both the carbon footprint and responsibilities of the various income classes within a country (Greenpeace India 2007).

[2] For simplification in calculations, a rate of US $1.00= INR (Indian Rupees) 40.00 will be used.

As India debates the appropriate climate strategy, it has come across a number of challenging issues, particularly concerning equitable actions that distinguish between those who contribute to climate change and those who are merely impacted by it. Ambivalence, and consequently, inaction, however, is not in India's own interest. As Indian climate campaigner, Malini Mehra, points out, "Our emissions now – at a time when the implications of our actions are crystal clear – are not without consequence." (Mehra 2007: 11). With new infrastructure being constructed every day, the decisions made today will last throughout this century.

Figure 3: Average per Capita CO2 emissions (tCO_2/yr)



Note: World avg. is 5.03 tonnes CO_2/yr (tCO_2).
Source: Greenpeace, 2007.

In an effort to break through the impasse, the Prime Minister unveiled India's first National Action Plan on Climate Change, which promotes eight national "missions" representing long-term integrated strategies for advancing India's development simultaneously with its climate change objectives (GoI 2008). Though it does not commit to specific emissions reductions targets, the Plan does have a defined approach for tackling some of India's largest adaptation and mitigation issues. Such initiatives are a good start, but more will be needed to shift India away from lock-in to its current projected energy path, and instead towards a path that secures its superpower aspirations.

Climate Change Scenario in India

Due to the unique confluence of India's geography, population characteristics and high-carbon energy dependence, climate change may have a greater impact on India than on other countries. Not only are the economic costs of fossil fuel dependence high, but when India accounts for the additional environmental, social and regulatory costs from climate change over the next century, the sums become exorbitant. According to calculations by the Carbon Disclosure Project (CDP), "the cost of climate change in India could even be as high as a 9-13% loss in GDP by 2100 compared to a 'no climate change' scenario" (CDP 2007: 12).

The greatest environmental impacts to India will manifest in a variety of ways:

- Temperature increases in India that are higher than the average global temperature rise predicted by the United Nations Intergovernmental Panel on Climate Change (UNIPCC)
- Changing and increasingly unpredictable monsoon patterns
- Declines in crop yields of up to 30% in South Asia by 2080
- Sea level rise, which may submerge land, infuse saltwater into freshwater sources, and create climate change refugees
- Retreating Himalayan glaciers that reduce India's freshwater source
- Shifting and exacerbated vector-borne diseases
- Increased frequency and unpredictability of extreme weather events (e.g. droughts and floods).

India may be especially vulnerable to high social costs as well due to the instability that could result for the 700 million people (about 60% of the population) who directly depend on climate sensitive sectors like agriculture, forestry and fisheries for their livelihoods. Furthermore, "Climate change, at a most profound level, disempowers by rendering traditional knowledge useless... bring[ing] confusion and helplessness as people lose their traditional capacity to 'read' the weather and adjust accordingly" (Mehra 2007: 6).

Threats to national security may also arise in the form of conflicts with neighboring nations like China, Bangladesh, and Pakistan over energy, water or migrating climate refugees. The costs of aggressive action on this front would certainly be enormous.

Finally, because of its heavy dependence on coal, India may be more susceptible to the impact of future changes in international climate change treaties. "As a result, future regulatory processes and carbon emission control policies such as carbon and tax penalties would have greater implications for India compared to other nations which are less dependent on coal" (CDP 2007: 6). These factors combine to reveal the vulnerable and even unstable future that India could face due to climate change.

Renewable Energy Overview

Addressing the challenges of a climate-constrained world will be an immense task for a country like India with a growing economy, a large population and the obligation to bring hundreds of millions out of poverty. A critical part of the solution will lie in promoting renewable energy technologies as a way to address concerns about energy security, economic growth in the face of rising energy prices, competitiveness, health costs, and environmental degradation.

To date, India has 12.6 GW of renewable energy excluding large hydro (MNRE 2008a), representing about 9% of total electricity capacity (see Figure 4). For the current eleventh Five Year Plan

Figure 4: Renewable Energy in India

Technology	Cumulative Achievements (MW)
GRID-INTERACTIVE	
WIND	8,757
SMALL HYDRO	2,181
BAGASSE CHP	801
BIOMASS	606
WASTE-to-ENERGY	56
SOLAR PV	2
SOLAR THERMAL	0
GEOTHERMAL	0
TIDAL/WAVE	0
OFF-GRID	
BIOMASS	95
BIOMASS GASIFIER	86
WASTE-to-ENERGY	24
SOLAR PV	2
TOTAL	12,610

SMALL-SCALE SYSTEMS	Cumulative Achievements
FAMILY BIOGAS PLANTS	4 million
SOLAR STREET LIGHTS	69,549
SOLAR HOME SYSTEM	363,399
SOLAR LANTERN	585,011
SOLAR PUMPS	7,148 nos.
SOLAR WATER HEATING (collector area)	2.15 million sq.m.
SOLAR COOKERS	620,000
WIND PUMPS	1,294 nos.

Note: Data as of 31 March 2008.
Source: MNRE 2008a.

period from 2007 to 2012, the GoI has outlined a target of 14 GW to 20 GW of additional renewable capacity, a very feasible goal given its previous achievements. In the 10th Five Year period from 2002 to 2007, in comparison, approximately 25% of total new power installations consisted of renewables, i.e. 6.5 GW out of the total 27 GW of new power, mainly due to additions in grid-connected wind power (CEA 2008).

As a result, India is today ranked fourth globally for installed wind capacity as well as second for biogas generation. At the same time, there are immense untapped small hydro resources in the north of the country, and excellent insolation and favorable new policies, which could make India a world leader in solar as well.

India's recent success in clean energy is just a beginning. The seven trends outlined in the following pages provide a glimpse of exciting developments to come, and reveal that with continued policy support, investment, and technological innovation, India could become a global leader in renewable energy.

I. Rise in Renewable Energy Investment

In 2007, the Planning Commission announced that the energy sector would require $125 billion dollars worth of investments during the current 11th Five Year Plan period up to 2012. With an increasingly favorable regulatory and policy environment along with a growing number of enterprising entrepreneurs and project developers, India ranked as the third most attractive country to invest in renewable energy, after the USA and Germany, in the Ernst and Young Country Attractiveness Indices (see Figure 5). Clean energy investors and entrepreneurs heard the call, and throughout the year a spate of announcements indicated that India, along with China, indeed was on the path to becoming one of the largest markets for renewable energy in the world by 2012 (Environmental Finance 2007).

Among the news bites from the venture capital (VC) and private equity (PE) community came announcements about a number

of new funds investing in the clean energy space.

Figure 5: Renewable Energy Country

Ranking*		Country	All Renewables	Wind Index	Onshore Wind	Offshore Wind	Solar	Biomass/ Other	Infrastructu
1	(1)	US**	70	71	77	56	72	63	72
2	(2)	Germany	67	66	65	68	73	68	66
3	(3)	India	66	67	76	44	62	60	66
4	(4)	Spain	64	65	70	50	72	57	73
4	(5)	UK	64	67	65	73	51	59	70
6	(6)	China	61	66	69	57	45	49	63
7	(7)	Italy	60	59	64	44	69	56	66
8	(8)	Canada	59	62	67	49	43	51	66
9	(8)	France	58	59	60	54	60	56	61
10	(10)	Portugal	57	58	63	46	62	49	64
10	(10)	Greece	57	59	63	49	59	43	60
12	(12)	Ireland	55	58	59	56	37	47	65
13	(14)	Australia	53	53	56	44	61	49	60
14	(13)	Sweden	52	52	52	52	44	57	53
15	(16)	Netherlands	50	51	51	51	50	43	49
16	(15)	Denmark	49	51	47	60	44	47	61
17	(16)	Belgium	48	52	50	57	36	37	53
17	(16)	Norway	48	50	50	50	32	48	53
17	(19)	Poland	48	51	53	45	42	36	46
20	(20)	Japan	45	46	48	40	48	34	51
20	(20)	Brazil	45	45	49	35	45	41	44
22	(22)	New Zealand	44	47	51	38	33	32	45
23	(23)	Finland	38	36	36	37	27	56	41
24	(24)	Turkey	36	37	38	33	38	27	35
25	(25)	Austria	35	30	41	N/A	48	49	49

Source: Ernst and Young, 2008.

According to Jaswinder Kaur, Executive Director of the India Venture Capital Association, "There are 10 to 15 active funds in this space but many are fundraising in 2008 for their next round with a specific cleantech mandate" (Kaur 2008). The funds are expected to close over the next six months to two years and would be deployed over the next one to five years. Not to be outdone by the private sector, Prime Minister Manmohan Singh announced in early 2008 that even the Indian government would set up a "venture capital fund" to invest in green technologies, energy efficiency and adaptation (PM Singh 2008).

Surveying the past few years of data, a 2007 report by UNEP and New Energy Finance shows an upward trend in investment in renewable energy since 2004 (see Figure 6). In 2006, VC/PE was extremely active with approximately $197 million invested, nearly half of which was private equity for expanding wind manufacturing capacity (UNEP 2007: 45). At the same time, asset financing in

Figure 6: Renewable Energy Investment in India

Source: UNEP/New Energy Finance, 2007.

India was quite vigorous with 79 deals executed, mostly for wind projects, totaling over $2 billion dollars of investment (*ibid*).

In 2007, meanwhile, VC/PE investment escalated to $267 million, amounting to 25% of the total energy PE deals in India (Cleantech Group 2008a). Figure 6: Renewable Energy Investment in India. The top three clean energy deals of the year included Moser Baer's raising of $100 million to partially finance the increase in its solar photovoltaic (PV) thin film manufacturing line from 40 MW to 600 MW by 2010, and two wind companies Vestas RRB India Ltd., and Regen Powertech Private Ltd., who raised $55.6 million and $25 million, respectively (Cleantech Group 2008b).

Other planned investments included: Suzlon's three-year expansion plan to invest nearly USD $1.4 billion to triple its wind turbine production capacity by 2009; General Electric's (GE) intentions to set up a green-field facility in India to manufacture 1.5 MW to 2.5 MW wind turbines; USA-based Signet Solar's goal to invest $2 billion over 10 years to set up three plants in India starting with a 60 MW annual production line and expanding to 1 GW; activity by Tata BP Solar to expand their existing plant to 180MW of solar cells and 125 MW of solar modules with an additional investment of $100 million; and Reliance Industries' announcement for a 1 GW solar PV module manufacturing plant in India at a cost of nearly $3 billion. Strong incentives for the manufacturing of solar cells and panels were, in part, responsible for the flurry of activity in that space.

In addition to incentives for manufacturing, a number of stimulating government policies in 2007 and early 2008 are playing a role promoting renewable energy generation as well. To welcome in the new year in 2008, MNRE proudly announced incentives (via a favorable generation-based tariff) to encourage installers and project developers to make use of the growing domestic supply of solar cells and modules to set up grid-connected solar power plants in India.[3] As a result, in 2008, India will have its first MW-scale solar PV plants.

[3] More details on solar incentive discussed in Trend 2.

In the wind sector, meanwhile, exceptionally favorable tax policies for accelerated depreciation as well as the proven status of the technology were the main drivers for investment. The wind tax incentive, however, is expected to soon be replaced by a generation-based incentive, similar to that available for solar. With 8.76 GW of wind developed so far, MNRE hopes the incentives will encourage the exploitation of 45 GW of additional wind potential; confident corporate players, meanwhile, insist that India has up to 100 GW potential. Small hydro as well, like solar and wind, will be another very promising technology for 2008 with significant untapped resources in northern India and developers observing attractive returns.

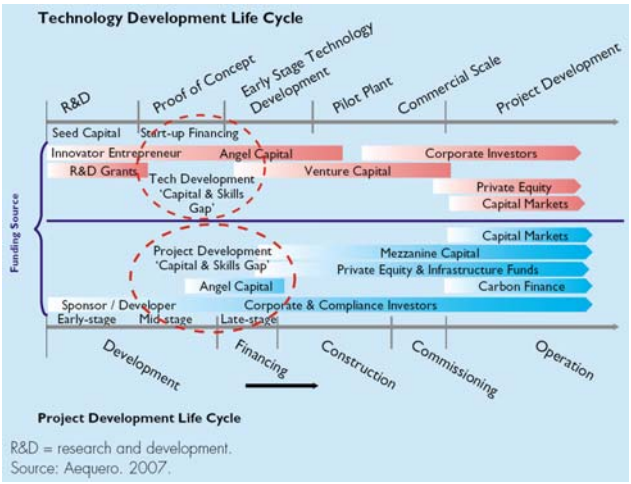
At the same time, recent approvals by the GoI in 2007 of several renewable energy special economic zones (SEZs) located near ports in Tamil Nadu and other southern states will further facilitate investment. The zones will focus on manufacturing, technology development, and supplementary products for the renewable energy sector, while offering special incentives for investment and streamlining administrative procedures for renewable energy companies.

An assessment of the numbers and headlines above shows that these are significant commitments on behalf of both foreign and domestic players in the clean energy sector. To capitalize on the growing interest and potential deal flow, certain strategic investment banks and other firms in the financial services sector are actively building expertise in mentoring, placement, fund advisory and capital-raising in the clean energy area. Financial service firms targeting such deals include the newly established Cleantech India, New Ventures India, Cleantech AustralAsia, and Yes Bank Ltd.

In spite of all the enthusiasm and activity by early movers, however, the sector is still at a nascent stage. One of the most significant issues today is the “capital barrier”: a gap between the Indian cleantech entrepreneurs who require anywhere between $100,000 and $2 million to fund the early stages of research and development, and the majority of investors in this

space who are looking to finance bigger deals (see Figure 7).

Figure 7: The "Capital and Skills Gap" in Clean Energy



Source: Asian Development Bank, 2007.

At least a few of the new funds planning to invest in this area recognize the gap and are seeking to find ways to obtain attractive returns from early stage and smaller-scale investments. In addition to this "capital barrier," other investment barriers include "novelty to the concept of cleantech, lack of information, multiple stakeholders with opposing views, policy constraints and lack of enforcement, and lack of technical know-how" (Cleantech Group 2008a).

Given these issues, "this is a fragile time when plans can change drastically or reverse, particularly... [when] putting large sums of money to work in a nascent, riskier sector," such as clean energy in India (Rosen 2007). Nevertheless, despite the early difficulties in closing investments, many expect the pace to pick up in the next few years. Lucrative exits by investors over the coming years will be the true test of success. While wind energy until now has captured the attention of most clean energy investors in India, many are seeing new opportunities evolving—some of which stem from the following dynamic trends presented below.

II. Indian States Lead the Way

In the last two years, renewable energy installations up to gigawatts, particularly in wind, initiated a sort of competition

and sense of pride among progressive Indian states on renewable energy. Despite the strong presence of a national Ministry of New and Renewable Energy (MNRE) to guide policies that facilitate investment, it is really state-led initiatives that determine the increasingly rapid pace of renewable energy development in India.

For example, MNRE is currently deliberating a Draft National Renewable Energy Policy for India, which proposes a national renewable portfolio standard (RPS) requiring 10% of Indian electricity to come from renewables by 2010 and 20% by 2020. However, it is up to the individual states - via the state Electricity Regulatory Commissions (ERCs) - to implement. In anticipation, twelve pro-active states have already done so with renewables requirements ranging from 0.5% to 10%, including Andhra Pradesh, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal (MNRE 2008b). Some states such as Karnataka are even considering an increase in targets from the existing 10% to 20%.

In addition to the RPS, which stipulates the *quantity* of clean energy that utilities in each state must purchase, the national government has promoted incentives to set the *price* that utilities must pay for that source. Again, the individual state-level ERCs must stipulate these tariffs (usually on a "cost-plus basis") and the utilities must apply them. Until recently, the utilities in India had a notorious reputation for insolvency due to poor management, power theft, etc. Only lately have select states begun to apply commercial principles to their previously bankrupt utilities, and some have taken positive steps towards unbundling power generation, transmission and distribution.

To date, the wind industry has experienced success in many states with little difficulty in payment from the utilities. This year solar developers are trying their luck since MNRE announced a new generation based tariff granting up to $0.30/kWh (INR 12/kWh) for solar PV and $0.25/kWh (INR 10/kWh) for solar thermal electricity. As Debashish Majumdar, Chairman and Managing

Director of the India Renewable Energy Development Agency (IREDA), cautioned however, "Winning the opportunity to receive the national subsidy is one thing, selecting a winning state is another" (Majumdar 2008).

Thus, the lesson to investors, according to renewable energy lawyer, Mark Riedy, is to "choose your states wisely" with each demonstrating "different levels of development and market–friendliness," and the scenario constantly changing (Riedy 2007). In general, renewable energy experts perceive some of the most favorable states to date to be Karnataka, Tamil Nadu, Maharashtra, West Bengal, Punjab, Gujarat and Rajasthan. An enlightened model for investors, then, is not unlike the model pursued by clean energy investors and developers in the USA, viz. to focus on particularly pro-active states that provide supportive policies from the ERCs, financially reliable utilities, and a secure investment environment.

III. Indian IT Will Help Solve Climate Change

"What isn't measured, can't be managed," asserts the carbon mantra. In the near future, there will an unprecedented demand for individuals and technologies that can measure, analyze and manage tremendous amounts of data on energy and emissions and help integrate smart, clean energy sources. With escalating pressure globally on companies and individuals to think about their carbon footprints, someone will have to provide the services and the products to help clients compete in an increasingly carbon constrained world. Who else but India, with its sophisticated IT sector, massive pool of highly intelligent and technically skilled people, strong ties to Indians in Silicon Valley, and its own domestic energy shortages, to develop the will power and skill power to do this?

In the buildings sector, Information Technology-based smart homes and buildings can empower individuals and building managers to act with informed purchases and changes in demand. Information on energy consumption in kWh, the cost of the consumption at that moment ("real-time pricing"), the

source of that energy (whether from coal or solar, for example), and the amount of CO_2 emitted per unit of energy consumed could be embedded in, and presented visually, on everyday products or buildings. These could be further integrated with a "smart grid" based on advanced meter infrastructure.

"Unlike traditional systems in which energy flows from utility to consumer, smart grid systems allow both information and energy to flow in either direction" (ACEEE 2007). These data can then serve as inputs into automated energy management systems or be sent wirelessly to customers, enabling them to remotely manage, and thereby optimize, energy demand, choose cleaner energy providers, or schedule energy use for off-peak periods.

One smart homes township in Hyderabad, Palm Meadows, has already incorporated an IT system in each house, which allows residents to manage their energy consumption based on a set of pre-fixed levels, both from the house or remotely by internet. The developer, SA Habitat, wanted homeowners to be able to make informed energy choices and later plans to work with start-up Valence Energy to build totally solar powered homes in combination with the IT platform. As other developers and architects incorporate these innovations into new property developments, data on average energy consumption and environmental impact of these homes and buildings could be presented standard to every buyer, just as the mpg or km/L rating is provided for new car sales. With an educated and informed Indian homebuyer, this trend could hopefully help reduce CO2 emissions in this sector.

In transport, meanwhile, another innovative Indian entrepreneur in Calcutta, EG Gas Limited, has developed a unique Radio Frequency Identification (RFID) based IT emissions monitoring system for measuring the GHG emissions from vehicles. Sensors applied to the vehicle collect emissions data and transfer it via RFID technology to data readers at petrol/diesel pumping stations. These stations serve as a common platform for data collection and monitoring since everyone must go there for

refueling. In a world with individual caps on emissions (according to the entrepreneur's eager expectations for the post-Kyoto scenario), this technology may prove essential for the accurate measure of emissions from road transport, the one emissions source that today most carbon calculators merely estimate with "best guesses."

Coinciding with the opportunity for green IT solutions in physical structures and transport, will be an emerging demand for carbon and environmental services, particularly in corporate activities. This could entail IT applications to measure carbon footprints, conduct product life cycle analyses, or assist in global green supply chain management. With Europe debating legislation in 2007 that would place a carbon tax on imported goods, it is not impossible that any company in the world that sells to the European market would soon have to keep track of the environmental footprint of every product produced.

Already debates have begun within progressive corporates in the USA and Europe over requirements that energy and carbon information (including production, transport, use, or all three, i.e. the full lifecycle) be printed on labels for manufactured goods, like clothes or furniture, and food products. Just as consumers compare market costs, so too will they be able to compare sustainability costs. With so much data needing to be tracked and managed, it is clear that IT technology such as digital controllers, smart sensors, and adaptive software and operating systems will play a critical role in addressing such needs.

These concepts are not new, but what is unrealized to date is the role that India is uniquely positioned to play. Infosys, India's leading IT company, conducted its first "carbon footprint" analysis in 2007 and found that 49% of its energy demand came from air conditioning (Parikh 2008). Recognizing it could be much smarter, the company decided to work towards a new goal of "carbon neutrality" with plans for green buildings, clean electricity purchases, and energy conservation measures within the company. In the future, they may soon see client business in this area as well. Wipro, another top Indian IT firm, already offers

renewable energy services to customers and is currently developing a suite of IT-enabled solutions to assist clients in achieving carbon neutrality.

Even if a client is not looking for "green IT" services per se, for IT companies "it's a great market differentiator that may sway a potential client considering different vendors when all other factors are equal" (Overby 2007). According to a study by the Brown Wilson Group on the outsourcing industry in general, "More than 21 percent of publicly traded companies that outsource have added 'green policies and performance' demands to their vendor contracts in 2007, and 94 percent plan on adding such clauses during renegotiations... [At the same time], 36 percent of private companies are now contemplating green policies for 2008 outsourcing contracts" (Brown 2007). As this trend continues, Infosys, Wipro, and other forward-thinking Indian IT firms will be strategically placed to take advantage of a very good business opportunity as individuals and organizations all over the world seek to operate cleanly and effectively in a carbon-constrained market.

IV. Small is big: Micro-finance and Micro-Utilities

It is widely acknowledged that a key to lifting millions out of poverty in India is the development of rural economies. As not everyone can move to the cities for a 'better life', income generating activities and markets must be nurtured in small towns and villages. Two critical components for fostering such economic enterprises, whether in urban or rural areas, are financing and energy.

In low-income areas, microfinance institutions (MFIs) are already taking care of financing needs with unique loan products customized to individuals without collateral or previous credit history. Increasingly, these same MFIs are also seeking clean, distributed energy products or services for their clients. At the same time, renewable energy companies are looking for opportunities to access untapped markets for their off-grid energy products. This new trend towards partnerships between

MFIs and clean energy companies in India can help loan clients expand existing businesses, start clean energy shops, or set up new "distributed utilities" in areas where there is no grid or grid unreliability hinders growth.

MFIs, more so than traditional financial institutions, have the potential to offer creative financing that makes clean energy systems more accessible and affordable, especially to the poor. They are able to provide flexible loans and structure their lending schemes and financial products in accordance with the needs of their low-income clients. For example, these MFIs are binding loan repayment rates to seasonal variations in energy expenditures or incomes in a way that reduces the impact of the often expensive energy technology.

In India a few MFIs, including Sewa Bank, Basix and SKS Microfinance, are especially proactive in developing various lending models for clean energy. In one model, money is lent towards the purchase of a clean energy technology for individual use. An example of this is Bangalore-based solar company SELCO's partnership with Sewa Bank to provide home lighting systems at affordable prices to poor customers using microfinance.

A second loan product, resembling a small business loan, involves lending to an entrepreneur who sets up a micro-dealership or retail shop to sell clean energy products to local customers. In addition, micro-assembly lines for assembling clean energy technologies from component parts could be developed as a new industry in villages. Grameen Shakti in Bangladesh envisions the creation of 100,000 rural "cleantech" jobs based on such models (Barua 2008). The most common technologies sold or assembled are solar home systems and lanterns using compact fluorescent lights (CFL) or light emitting diode (LED) lights, hand-crank lanterns, micro-wind turbines, biogas digesters, or biomass gasifiers.

A third, and perhaps the most interesting if challenging, model involves lending to an entrepreneur to create a "micro-utility"

that provides energy services to local, off-grid customers based on their usage. Grameen Shakti has found this model to be quite successful, with support for over 10,000 micro-utility entrepreneurs who sell solar electricity generated by panels on their roofs directly to neighboring shops. In India, meanwhile, TERI, through its 'Light a Billion Lives' campaign, is creating a different kind of solar utility entrepreneur who rents out charged lanterns and batteries on a daily basis to customers for a fee.

At the same time, other groups like DESI power are nurturing entrepreneurs to create larger scale, community-sized utilities using biomass gasification technology; while S3IDF, a different non-profit, has developed a model based on biogas entrepreneurs who sell clean cooking gas to customers. These micro-utility models, combined with microfinance, represent a powerful opportunity for local communities to take charge of their own energy provision in ways that empower the poor and promote economic growth.

To facilitate the financial feasibility of such models, SKS Microfinance is also considering establishing a Micro Carbon Credit Exchange with the goal of bringing carbon revenues generated by these projects directly to the villagers using clean energy. To understand the implications of this, a 40-Watt solar panel used to replace a diesel generator saves about 0.25 tons of CO_2 per year; the emissions savings from which could then be monetized and sold to buyers around the world (Richards 2007). Taking advantage of carbon revenues from such technologies could make a difference to low-income consumers by lowering the payback period, and thereby further helping to disseminate the technology.

For renewable energy companies seeking to tap the 412 million individuals in India without access to electricity (IEA 2007), linking with an active MFI can prove quite strategic with benefits in supply chain management, network outreach, established infrastructure, logistics, marketing, and consumer finance to poor and often remote markets.

Before proceeding too quickly, however, many financial risks may need to be mitigated through appropriate instruments such as escrow accounts, security deposits, credit enhancements, payroll deductions, etc. In particular, for companies with business models relying on technologies with high up-front costs, servicing requirements, and customers with low incomes. Moreover, careful attention should be paid to the structure of the partnership with an understanding of each partner's responsibilities (Morris 2007). When done thoughtfully, and with the appropriate risk mitigation mechanisms in place, however, this exciting combination of microfinance and clean energy represents a dynamic new trend in expanding affordable and clean energy access.

V. "Hello" Clean Transport, Otherwise "Ta-ta" India[4]

If there is anything to stimulate the search for alternative transport, it is the image of polluted cities clogged with vehicles - an image of impending catastrophe for India's future. In January 2008, Tata released the ultimate low-cost people's car for India. Not to be outdone in the world's future largest car market, Mahindra, Hyundai and other car-makers announced plans for similar vehicle lines. Priced at $2500 (the "one lakh rupees" car),[5] this new "people's car" could allow every member of India's

Figure 8: Growth of Motorized Transport Vehicles (millions)

	1970-71	2001-02	Growth Rate
Two-wheelers	0.58	41.48	15.3%
Three-wheelers	0.04	1.88	14.0%
Cars	0.54	5.72	8.2%
Buses	0.09	0.55	6.1%
Trucks	0.34	2.09	6.2%

Source: Planning Commission, 2006.

Figure 9: Growth in CO_2 Emissions for Motor Vehicles

	Post-2000 Models (kg CO_2 per km)	Post-2005 Models (kg CO_2 per km)	Change in Fuel Economy from 2000 to 2005 (km/L)
Petrol Car (>1,400cc engine)	.143	.173	16 to 13
	1996-2000 Models (kg CO_2 per km)	Post-2005 Models (kg CO_2 per km)	Change in Fuel Economy from 2000 to 2005 (km/L)
Diesel Car (<1,600cc engine)	.129	.149	20 to 18

Source: CSE, 2008.

[4] "Ta ta" is an English colloquial expression meaning "goodbye"

[5] "One lakh rupees" equals INR. 100,000. Cost to the consumer will be about $3,000 with taxes.

growing middle class to experience the feeling of independence on the road, and "success" in every household. In response, however, many anxiously asked, "Where are the roads? Where will the oil come from? How will India continue to walk, much less breathe?"

According to India's Planning Commission, diesel consumption grew 5.8% per year while petrol consumption grew 7.3% per year between 1980 and 2004 (Planning Commission 2006: 10). This was due to the growth in personal transport and road haulage (see Figure 8). Growth projections for the future show no decline in sight and are predicted to be much higher than historical growth rates. On top of increased energy consumption, recent research shows that new vehicles in India are actually emitting more CO_2 per km than earlier vehicle models (see Figure 9). As a result, in the five years between 2002 and 2007, "the CO_2 emissions load from cars has increased by 73% and from two wheelers by 61%" in Delhi alone (CSE 2008). With imports accounting for 75% of India's crude oil needs, oil prices currently above $120 per barrel and some Indian cities approaching the top of global rankings in pollution, it is urgent, therefore, that the country find more affordable and clean sources of energy for transport.

In 2003, Delhi garnered much attention for its successful implementation of the world's largest public transport fleet running on cleaner burning compressed natural gas (CNG). However, as global demand rises, gas prices continue to soar and individuals increasingly eschew public CNG transport in favor of private petrol vehicles, the efficacy of this policy as a long-term sustainable strategy to be implemented across India may be questionable (Economic Times 2007).

With all of India's major cities facing similar dilemmas and deliberating on a variety of urban transit choices before them, alternative fuels based on electricity or biofuels are looking especially appealing. One Indian plug-in electric carmaker, Bangalore-based Reva Inc., is already producing its own low-cost people's car. Priced at $8,750 (INR 350,000), the Reva car

travels 80 km on a fully charged lead-acid battery in which the "electric fuel" costs the equivalent of $0.75/gallon (~INR 8/Litre) of diesel equivalent. By the end of 2008, the company plans to launch a lithium-ion battery version which would be capable of traveling 150 km on a full charge. Not to miss out on these emerging opportunities, Tata Motors has also formed a partnership in 2008 with Chrysler to produce electric mini-trucks for sale in USA markets.

More appropriate to the Indian context, however, are developments in clean fuel two-wheelers. During the past three decades, motorbike usage has experienced the highest growth rates of any form of motorized transport in India (see Figure 8). As an example of an alternative, one start-up, Kabirdass, developed an electric plug-in scooter priced at $1,125 (INR 45,000) that does 70 km on a full charge and is suitable both for customers' inner-city driving needs as well as their wallets. Currently, there are over 30 electric bike manufacturers in India. Reliability and cleanliness of the grid (i.e. how clean the electricity is that charges the vehicle) are clearly critical issues, but this technology could make sense for urban application today and, surely in the future, as India pushes forward with an aggressive renewable power agenda.

Biofuels may be yet another option as a transition fuel towards other cleaner options in the future. Jatropha, a non-food oil-seed bearing tree, in particular, has captured the imagination of Indian politicians who envisioned biodiesel plantations on marginal lands throughout the country, benefiting poor farmers and reinvigorating depleted, non-cultivable "wasteland." While the GoI has considered but not yet mandated a national biodiesel blend, states such as Maharashtra, Chattisgarh, Rajasthan, Madhya Pradesh and Jharkhand have taken the lead with favorable land grant policies and other incentives. As a result of such measures, by the end of 2007 biodiesel capacity in India had expanded to more than 570 million liters (150 million gallons) per year (Riedy 2007). The big players in 2007 included, among others, D1 Oils, BP, Neste Oil, and the Indian Railways.

Ethanol, meanwhile, recently gained renewed attention when the government set a 10% ethanol blending mandate nationwide for October 1, 2008. Despite being the world's second largest sugar producer, it is questionable however, whether this new target based on water-intensive energy crops such as sugar cane should be pursued over other clean fuel alternatives. Particularly, given the fact that oil companies failed to procure enough ethanol to meet the 5% target from the previous year. Cellulosic ethanol, meanwhile, a popular topic in the USA, is scarcely discussed in India. Mumbai-based Praj Industries, funded by Khosla Ventures, is the most visible developer of the technology in India. However, investors in biofuels are urged to move extremely carefully, particularly in India, as controversies have arisen over a variety of issues in recent years.[6] Proceeding sustainably and thoughtfully with close attention paid to the global biofuels debate will be critical for achieving success in bio-based alternative transport.

Ultimately, no private transport option can surpass the efficiency and practicality of a well-designed and well-maintained public transport system - particularly in India's densely populated cities. In response to exacerbated traffic problems, several Indian metropolises have recently begun construction of underground metro lines and bus rapid transit lines. Concomitant with the foresight of these progressive policy-makers and innovative clean fuel and vehicle entrepreneurs, however, will be the education of the consumer. Only with a "mental shift" among people to redefine "success" and demand clean transport, can the critical "modal shift" towards a sustainable transport paradigm take place.

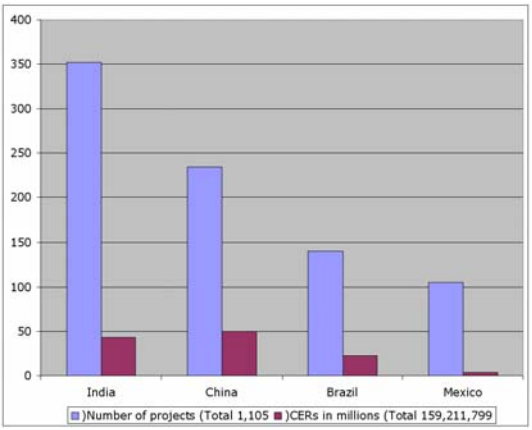
VI. A Creative Approach to Carbon Credits

No longer relegated to burning dull industrial gases or setting up renewable energy projects in mature technology sectors like

[6] Controversies that affected recent investors include: the food vs. fuel debate; the use of irrigated land rather than the proposed "non-irrigated wasteland"; the displacement of farmers; and patent issues over the commercial exploitation of an indigenous Indian plant.

wind, creative carbon crusaders in India, in both the private and public sectors, are stretching their imaginations to the limit to identify new ways to reduce GHG emissions. As the fourth largest emitter of GHG's at 1.2 Gt CO_2 per year, India is the largest contributor of Clean Development Mechanism (CDM)[7] projects (32%, 352 projects), and the second largest (27%, 43 million CERs)[8] after China in terms of carbon credits issued (see Figure 10).

Figure 10: CDM Pipeline Projects and CERs



Note: Data as of 30 June 2008.
Source: UNFCCC

With the lure of additional revenues from carbon credit sales, everyone is jumping on the carbon bandwagon. Many of the large Indian corporates such as Reliance, Ansal, Tata Chemicals, Ispat Steel, Jindal Steel, Hindustan-Lever, ITC Paperboards, and Mahindra have been seen in newspaper headlines for their recent ventures into wind farm investments, energy efficiency, or reductions in industrial gases. Not to be outdone by the high-profile players, smaller non-traditional enterprises such as tyre companies, hotels, home-builders and chicken farmers are setting up innovative projects as well.[9]

[7] The Clean Development Mechanism (CDM) is an agreement under the Kyoto Protocol allowing industrialized countries with a GHG reductions commitment to invest in projects that reduce emissions in developing countries as an alternative to making reductions in their own countries. One Certified Emissions Reduction (CER), the currency for exchange, is valued at 1 metric ton of CO2-equivalent reduced. The most important factor of a carbon project is that it establishes "additionality," i.e. that it would not have occurred without the additional incentive provided by emission reductions credits.

[8] See Note 9.

[9] A list of the companies in India and elsewhere that have earned carbon credits can be found at: http://cdm.unfccc.int/Issuance/cers_iss.html

In the transport sector, meanwhile, Delhi's Metro became the first railway in the world to qualify for carbon credits in January 2008. By using regenerative braking technology, which captures and stores the energy released during braking, Delhi Metro is able to reduce its electricity requirement by 30%. Converting these energy savings into emissions reductions, they "can now claim 400,000 CERs for a 10-year crediting period which translates to INR 1.2 crores [($300,000)] per year for 10 years" (Live Mint 2008).

Likewise, pioneering commercial bus or truck operators can also receive carbon revenues based on a recently approved methodology granting credits for the "introduction of low-emission vehicles to the commercial vehicle fleet" both for passenger and freight transport (UNFCCC 2007: 9). Applicable clean transport technologies include CNG, electric, and hydrogen vehicles, among others.

Perhaps soon even non-motorized transport such as bicycle promotion initiatives, and efficient urban planning options such as analyzing the emissions implications of siting particular urban activities, could be pursued as projects under the CDM. The latter could include activities such as shopping and entertainment, within close proximity of new metro stations compared to their placement in suburbs. Such ideas represent a crucial opportunity for India to develop a sustainable transport sector and, at the same time, increase revenue streams. In other words, the creative application of carbon financing to the transport sector is just "revving" up.

Programmatic CDM for other areas such as energy efficiency and rural electrification is also a useful tool that will facilitate new streams of carbon revenues. Programmes could include credits received for energy efficient street lighting projects in municipalities, the replacement of electric water heaters with solar heaters, the application of building efficiency standards to businesses and homes, and low-income sustainable housing projects. Two particularly exciting pilot projects in Andhra Pradesh and Haryana are planning to use carbon revenues to finance

the replacement of 1.5 million incandescent light bulbs with CFLs for savings of 25 MW. The programme, when implemented across the entire country, could replace 400 million light bulbs and save 6 to 10 GW (Mathur 2008).

In anticipation of the important role that India is expected to play in the carbon market, the Multi Commodities Exchange of India (MCX) and the Chicago Climate Exchange (CCX) entered into a partnership to create a platform for trading CERs in India. In January 2008, the MCX took the first step and launched futures trading in carbon credits with the goal of ensuring better price discovery of credits and helping mitigate risks associated with buying and selling.

One issue that is holding many people back, however, is the lack of certainty regarding the post-2012 future of the carbon market and prices. As a result, some investors are caught in a dilemma in which they "will heavily discount CER revenues to the project beyond 2012, making the CER revenue stream insignificant to the project. This in turn defeats any argument that the CDM component of the project is material from a financial perspective and..., [thereby], render[s] the project ineligible for CDM" (ADB 2007: 60). Thus, from the corporate and investor perspective, the sooner a global agreement can be reached to provide certainty to investors and traders, the better.

Apart from revenues for participating companies, the CDM - arguably more than anything else - has catalyzed awareness on the topic, with headlines running nearly every week about the latest developments in qualifying carbon projects in India. Nevertheless, "the private sector, while appreciating the benefits from CDM projects, has yet to fully engage with the potential impact of climate change on business" (CDP 2007: 8). Unlike in the USA and Europe where major corporates are putting climate risks and opportunities at the top of their agenda, in India only recently have a few industry leaders emerged to take the first steps towards managing their own carbon footprint.

Regardless, for India to get the maximum benefit from the carbon

market, it cannot depend on the private sector alone. The country should build the capacity of its public sector agencies to avail of carbon finance regularly with all major infrastructure and urban development projects systematically screened to check eligibility for carbon credits. The success that Indian companies have found in the international carbon market is contagious and surely the public sector will not be far behind in 2008. Despite questions about the effectiveness of the carbon market as a way to solve climate change or not, India, with its boundless creativity and some stable post-2012 global policies, is certain to be an exciting lab for innovative carbon financing in the name of sustainable development.

VII. A New Market for Indian Corporates: Rural Renewables

Just as "Walmart became a clean energy market maker" in the USA for 2007, so too could several major Indian corporates be drivers in India in 2008 (Makower 2007: 2). As they reach into rural areas of India, many companies are discovering an expanded role to their businesses; in particular, in electricity provision. These companies are finding that in order to tap the supply of workers for enlarged operations in rural India, they need to bring electricity to these areas as well.

Enlightened rural clean energy entrepreneurs, like DESI power and SELCO, have always known that successful village electrification occurs not just when a light bulb is installed, but when income generating activities are created so that customers are able to pay for the electricity. A light bulb, in and of itself, does not necessarily engender "sustainable development". Rather, a job utilizing clean electricity does.

Until recently, this trend in electrification only went one way; that is, clean energy entrepreneurs worked relentlessly to both provide electricity services as well as foster micro-enterprises to create jobs that would productively use their electricity. Thus, the energy companies had to create the demand for their product. As an example of this, in one village electrification

project, DESI Power set up both a 75kW biomass gasifier and a rural job-training center to nurture businesses that would productively use the electricity generated by the biomass power plant.

Today, however, the trend is beginning to go both ways. As large corporates increasingly bring jobs and products to rural areas, these behemoths are looking for alternatives to standard diesel generators, the operations of which often cost $0.20-.0.37/kWh (INR 8-15/kWh), depending on the remoteness of the location. Three companies, leaders among their peers of "India Inc.", provide forceful examples of this trend.

In an effort to cut costs in an increasingly competitive IT industry, as well as contribute to development in India, Satyam, a major Hyderabad-based IT company, adopted an extremely innovative business model "outsourcing their outsourcing to villages" (Friedman 2007). In these villages, rural college graduates can live a peaceful life close to home and the company benefits by paying half the wages of its urban workers. Today the rural outsourcing centre relies on diesel generators and sixteen car batteries when the grid electricity fails. Displeased with the expense, noise and pollution of this dirty energy source, however, Satyam is now driven to find a distributed clean energy source that will not only expand its business to more areas where electricity is often extremely unreliable, but also sustainably develop the surrounding villages to create a comfortable life for workers who might otherwise leave to seek jobs in the city.

After visiting one of Satyam's rural outsourcing centers, *New York Times* journalist Thomas Friedman mused, "If only ... If only we could make a breakthrough in clean, distributed power — an ET [energy technology] revolution — it could drive the IT revolution into every forgotten corner of the world to create jobs, light up schools and tap the innovative prowess of rural populations, like India's 700 million villagers. There is a green Edison growing up out here — if only we can give them the light to learn" (*ibid*).

ITC, meanwhile, a major Indian conglomerate, launched a successful IT initiative way back in 2001 called e-Choupal. Its internet kiosks, set up in remote village centers throughout India, allow farmers to check market prices and sell directly to ITC (or anyone else, for that matter) without profiteering middlemen in between. ITC trained one e-Choupal entrepreneur at each kiosk to charge a fee for reading information on the computer to farmers. To power these remote IT kiosks, however, ITC discovered that it could not always rely on the unpredictable grid, or on the option of transporting expensive diesel fuel to remote areas. The most practical alternative solutions were based on renewable energy utilizing solar panels with back-up batteries, a diesel hybrid, or, given its extensive agricultural linkages, developing a reliable biofuel supply chain for biomass-based power.

The third and perhaps most influential example is Reliance Industries, who like ITC, developed a radical farm-to-market business idea using clean energy. Under the banner of Mukesh Ambani's new "holistic model of development," Reliance has incorporated a provision for a 1-2 MW solar power plant in many of the villages where it is also setting up rural food processing centers that do not have reliable grid electricity. Similar to Satyam's case, these solar plants will not only power Reliance's facilities but also bring sustainable development to the neighboring villages.

Do not be mistaken. These are not just corporate philanthropy initiatives to promote goodwill. These companies have recognized that a critical prerequisite to expanding their businesses into India's rural areas is often to provide off-grid electricity solutions as well. For smart corporate decisions-makers looking for a cost-effective energy source, renewables are the only option. It may be that this interest of large companies eager to outsource, build in, and sell to rural markets will be the true accelerating force for the revolution in rural energy provision that the world has been waiting for.

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Abbreviations

CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CER	Certified Emissions Reduction
CFL	Compact fluorescent light
CNG	Compressed natural gas
CO_2	Carbon dioxide
ERC	Electricity Regulatory Commission
GHG	Greenhouse gas
GoI	Government of India
Gt	Gigatons
GW	Gigawatt
IEA	International Energy Agency
INR	Indian rupees
IREDA	India Renewable Energy Development Agency
IT	Information technology
km	Kilometer
kWh	Kilowatt-hour
LED	Light emitting diode
MFI	Microfinance institution
MNRE	Ministry of New and Renewable Energy
Mtoe	Equivalent of one million tons of oil
MW	Megawatt
PE	Private equity
PV	Solar photovoltaic
RPS	Renewable portfolio standard
SEZ	Special economic zone
tCO_2	Tonnes CO_2/yr
UNIPCC	United Nations Intergovernmental Panel on Climate Change
VC	Venture capital

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